services which Ehrlich and his pupils have rendered humanity. Such vast progress has already been achieved in chemotherapy that it will necessarily be only a matter of a short time when it will become possible to definitely arrest the ravages of such terrible diseases as syphilis, recurrent fever and sleeping sickness. Perhaps cancer, the cause of which has been ascribed by some investigators to organisms resembling the spirochete of syphilis, will also be found amenable to chemotherapy.

This marvelous success of modern therapy is, in a large measure, due to synthetic chemistry, which in the past has already rendered invaluable assistance to the medical practitioner by furnishing him such efficient remedies as antipyrin, phenacetin, trional, veronal, hexamethylen-tetramin, and aspirin. How, in the light of these positive advances, can we explain the attitude of those few who are still opposed to progress in medicine to which our science has chiefly contributed. A few years ago when we celebrated the birth of synthetic chemistry by commemorating the fiftieth anniversary of Perkin's discovery of the first anilin color, one of these obstructionists stated in a discussion that he believed very few useful drugs had been put out by the manufacturing chemists, and that we should be better off if Perkin had never discovered coal-tar products. The anilin colors were cheap and gaudy and did not last, and the coal-tar drugs were in the same class. He believed that the good that coal-tar products had done was being neutralized by the harm.

Let us hope that after a closer study of the subject this short-sighted man has meanwhile learned that he is wrong in every particular; for there exist coal-tar dyes which are ever so much faster than any coloring matter supplied by nature, and coal-tar derivatives in the hands of competent physicians do as little harm as any active drug in the pharmacopœia.

In fact, it is no exaggeration to say that there is scarcely a department in medicine that has not directly benefited through the discovery of the coal-tar products and especially of the anilin dyes. It has provided the anatomist and pathologist with the means of staining various tissues and thus of studying not only their normal structure but the alterations caused by disease. It is the foundation upon which has been built the modern science of bacteriology, enabling the investigator in this field to distinguish between the different disease organisms and to determine their presence by various tests, and now it bids fair to equip the physician with the most potent weapons in the warfare against disease.

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THE INSTRUCTION OF LARGE UNIVERSITY CLASSES

THE great increase of students in universities has brought up the problem of instructing students efficiently in large classes. The problem presents so many difficulties, and is one that so many instructors are wrestling with, that we have thought that it might be of value to describe the methods of handling large classes in a physics course in which there are lectures, recitations and laboratory exercises.

In this course there are registered about 400 students. Two lectures are given each week together with one quiz and two two-hour laboratory periods. The course continues throughout the college year, and covers the usual range of topics of a course in general physics. The lectures are given on Monday and Wednesday mornings at nine o'clock and repeated at eleven o'clock on the same days, the class being divided equally for the two periods. Experience has shown that 200 is a maximum number of students for experimental lectures, even with a good lecture

room, this not only on account of seeing, but also on account of holding the attention of all students.

The quiz is given on Friday, and is based on the topics covered in the lectures. The quiz sections are made up of from 18 to 25 students, the plan being to keep the number down to 20 if possible. These sections meet throughout the day, not all of them at the same hour. A mimeographed quiz sheet is prepared under the direction of the lecturer, and forms the basis of the quiz. The quiz instructors meet with the lecturer before Friday for a discussion of the quiz sheet, thus securing uniformity of presentation.

The laboratory work runs parallel with the lectures, and frequent conferences between instructors in both courses gives unity of presentation and of topics, so that the two courses are practically one. With such large classes it is evidently necessary to have a large number of students scheduled for laboratory at the same hour. This means either a large section in one or two large rooms or else a number of small sections in smaller rooms. Small separate sections involve a considerable number of experienced instructors, each more or less independent, and this presents a difficult executive problem. Even with plenty of money it is not easy to get and keep a large number of instructors of this kind, and harmony among them is also not always easy to maintain. Then it is not always possible to get a large number of separate laboratories. We have used the plan of a large section, in a large laboratory, with an efficient executive aided by assistants, and have duplicated apparatus throughout so as to unify the instruction. Three experiments are run at one time, and there are ten sets of apparatus for each experiment. Thus if two students work with one set of apparatus, 60 students can be accommodated in a section. The student performs these experiments in rotation, one at each meeting of the section, thus taking three periods. The fourth period is not taken for experimental work, but half of it is used for an oral or written quiz on work of the preceding experiments and the remaining half for a discussion of the next set of experiments. The practise is also followed whereby the section is divided into three parts, each division meeting with an instructor for a few minutes at the beginning of the laboratory period for a discussion of the experiment about to be performed. Students are supplied with printed directions written especially for the apparatus and experiments of this course.

On arriving at the laboratory, the student is given two blank data forms that indicate the experiment to be performed, and the table in the laboratory at which the student is to work. The student is given also a key to an apparatus locker. He secures the necessary apparatus and takes it to the table assigned to him. Presently he is joined by a second student who has received the same assignment as the first student except that he is given only one blank data form and no key. These two students perform the experiment together, record the data in pencil on the third blank data form, copy this data in ink on the two remaining data forms. Meanwhile the instructors go around to give help when needed. The general rule is to have one instructor for each fifteen students, but the instructors need not be all experienced teachers. One instructor is in charge and is responsible for the period. Upon completion of the observations the apparatus is returned to the locker, the table is cleaned up and the three data forms and key are presented to the instructor. The data forms are stamped with the date, the pencil copy being retained by the instructor, and an inked copy by each student to be used in writing his record of the experiment. This record is due a week later bound in a printed manila cover.

The laboratory procedure is given in detail in order that several fundamental principles may be brought out. The method is such that a section of 60 students may be started in five minutes, and the instructors are then free to go around, asking questions and giving advice and help. By having the apparatus in lockers, the laboratory is kept orderly at all times. Furthermore, it is easy to keep

account of the apparatus. Practically no apparatus has been lost in years. Each student on opening the apparatus locker must check over the pieces and report anything missing or broken. If such a report is made, the responsible student is located at once by consulting the records of the previous section. The use of inked data sheets also helps to reduce temptation. The paper of the data blank is such that any erasure of the ink is detected at a glance. The student is further deterred from dishonesty because of the knowledge that the instructor has a copy of the original data.

The "doctoring of results" by students is due to their desire to secure a better grade. With this thought in mind, a procedure has been established minimizing the credit given for the data taken, and magnifying the other parts of the experiment. The actual grading is made up according to the following values: neatness and condition of place of working 10 points, diagram of apparatus 5 points, method of working 10 points, theory of experiment and answers to questions 40 points, data taken 35 points, with a total of 100. A form printed on the cover shows the amounts allowed for each part of the work, so that the student can see where he is deficient. The method of grading the data is such that very accurate results are not required. Average results are not severely graded, so that a student learns he will not suffer severely if his observations are those of average conditions. The practise of requiring very accurate results with the penalty of a repetition of the experiment when the data shows a departure from these required results, encourages the practise of "doctoring data." The present plan of placing the credit on the *interpretation* of the results seems better in theory and is found more satisfactory in practise. Of course work that is careless or very poor must be repeated, and for the first few weeks of the course a considerable number are required to repeat or to rewrite work. Excellent work is encouraged by marking it with exceptional grades.

It is realized that the above plan followed in the laboratory work is to be criticized because it tends to make the laboratory a machine that will turn out so many students all in the same way. It is hard to see how this can be entirely avoided with large classes. An effort is made to keep quiz sections small in number of students, so that frequent opportunities are offered for expression of original ideas. The development of individuality is also considered in writing the directions for performing experiments.

Final examinations are given at the end of each semester in both the lecture and the laboratory work. The final examination, however, is given a weight of only a third or less in the total grade, the class work and written quizzes counting most in putting a mark on the student's work.

Some of the methods which we have used have been chosen because of local conditions, but many of our conditions are similar to those found in all larger institutions, particularly in institutions with large engineering colleges. We change details of the course each year, but the above represents a general plan which has been found efficient in instruction, and easy to manage.

A. P. CARMAN
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UNIVERSITY OF ILLINOIS,
November, 1910

THE AGRICULTURAL PRODUCTION OF THE UNITED STATES[1]

YEAR after year it has been my privilege to record "another most prosperous year in agriculture." Sometimes the increased prosperity has been due to weather unusually favorable to agriculture, sometimes to higher prices, caused either by a greater yield or demand, or by a scant production, but usually the advance in farmers' prosperity has been in spite of various drawbacks. It would seem that this country is so large in extent and has such varied climate, soil and crops that no nation-wide calamity can befall its farmers. Combined with this strong position in agriculture, the nation may now begin to derive

[1] From the annual report of the Secretary of Agriculture.